The Hydric Soil Technical Standard

2007

Deliberations of:

National Technical Committee for Hydric Soils (NTCSH)

NTCHS Recommendation for Application of the HSTS

- The NTCHS recommends that the HSTS be used to:
- a. evaluate the function of wetland restoration, mitigation, creation, and construction,
- b. evaluate onsite the current functional hydric status of a soil, and
- c. with appropriate regional data modify, validate, eliminate, or adopt hydric soil field indicators for the region.

Standard Requirements

- 1. Anaerobic Conditions
- 2. Saturated Conditions

1: Anaerobic Conditions

- For a soil to meet the Anaerobic Conditions part of the standard the must meet either
  - Part 1: The requited Redox Potential(Eh) as detailed below, or
  - Part 2: The required reaction to alpha-alpha-Dipyridyl as detailed below.

1: Anaerobic Conditions

- Confirmed by Redox Potential (Eh) data, or
- Confirmed by reduced Iron (FE++) data, or
- IRIS tube data.
- In-situ pH data are needed and on-site precipitation data are needed.

1: Anaerobic Conditions

- 5 platinum electrodes are installed at 25 cm in most loamy and clayey soil materials, 12.5 cm in most sandy soil materials, or 10 cm in soils that inundate but do not saturate to a significant depth.
- Electrodes are installed at the appropriate depth as measures from the muck or mineral surface (with a few exceptions; see last slide).

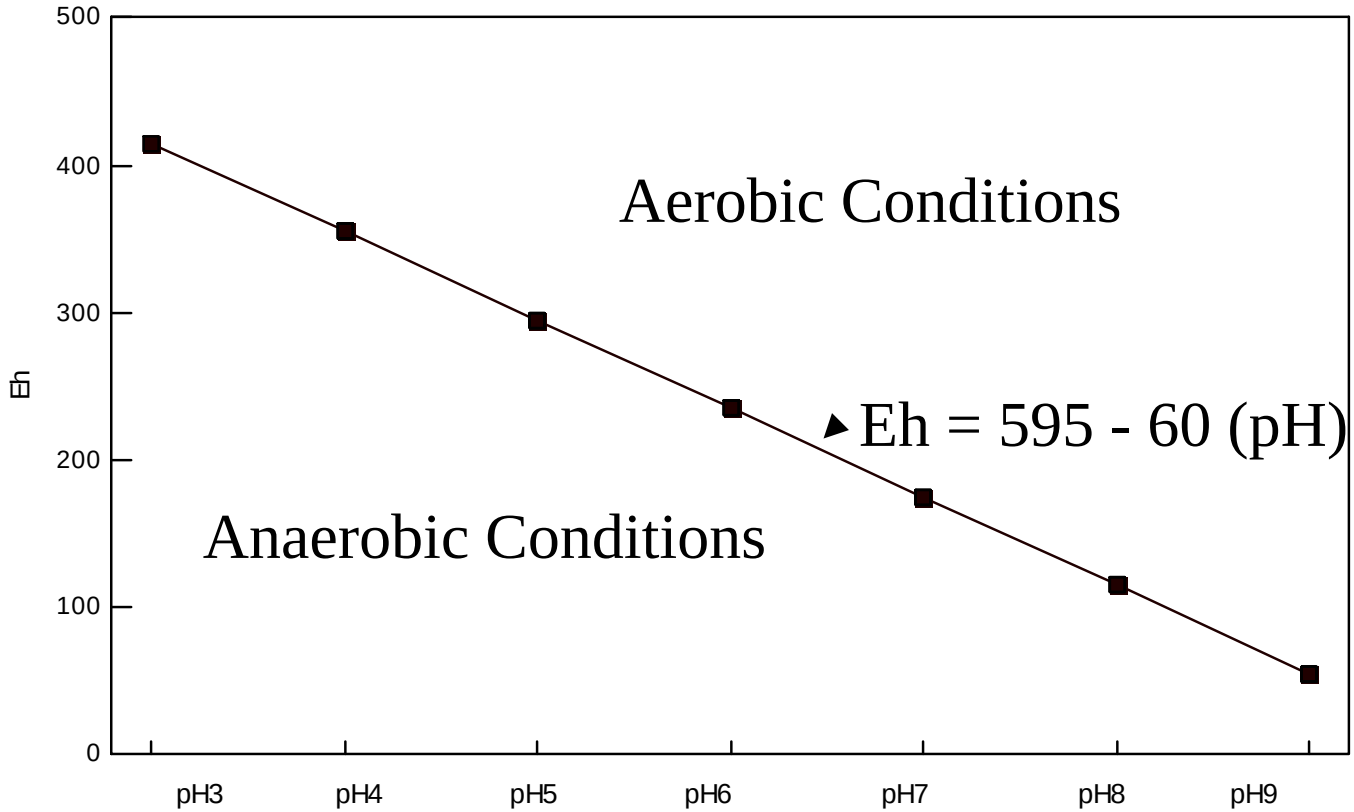
1: Anaerobic Conditions

- Three replicate samples within electrode installation depth are tested by alpha-alpha-Dipyridyl.
- One soil pH measurement is taken in-situ at the time Eh is recorded.

Interpreting for Anaerobic Conditions: Part 1

- A soil meets Anaerobic Conditions part of the standard if redox potential (Eh) measurements of < 175 mv at pH 7 exist. EH requirements are adjusted for pH on a line with a slope of negative 60.
- This Eh/pH line is used for soils with pH values of 3-9. It was not developed for any specific mineral species.

1: Eh/pH Line for Determining Aerobic or Anaerobic Conditions

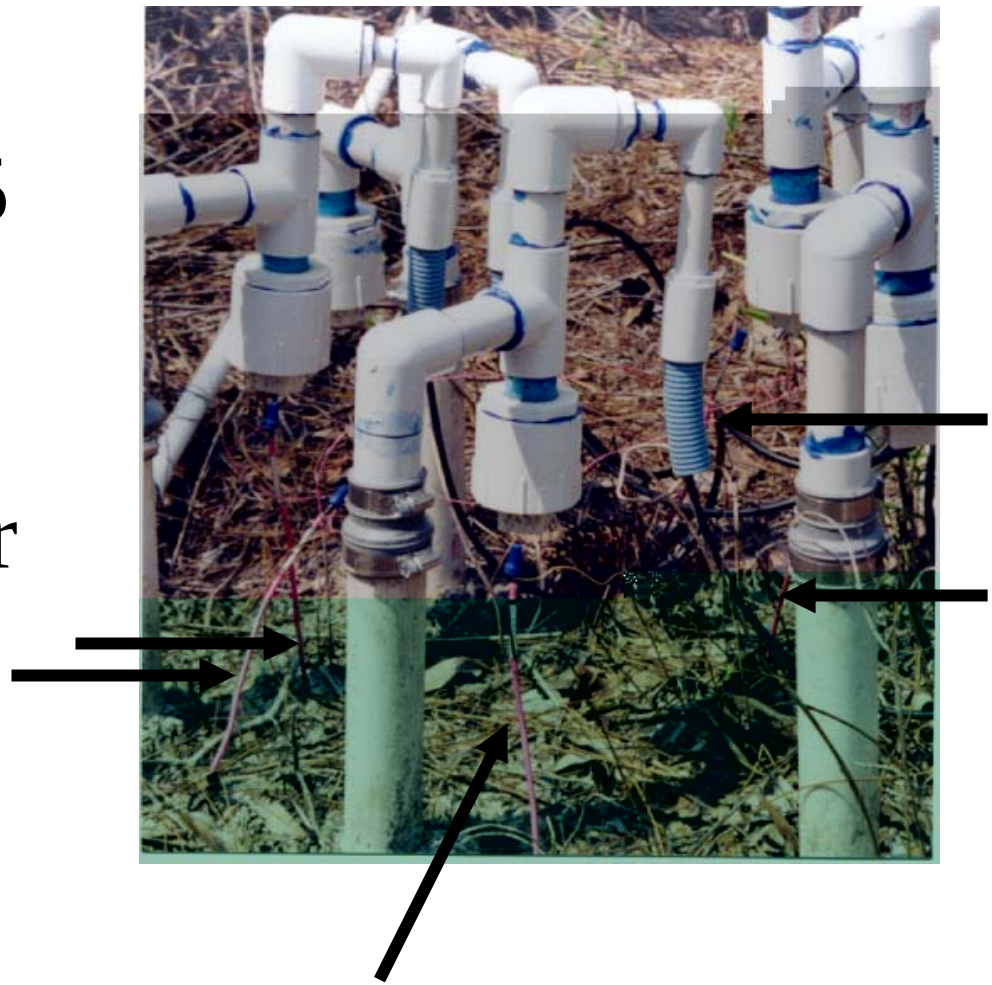


1: Anaerobic conditions and In-situ pH data (for Part I)

- Since soils (as they become saturated) tend to have pH values that move toward neutral (pH 7), in-situ pH values are used to locate the precise point on the Eh/pH line.
- pH is measured on a saturated paste in-situ. Water pH can be used of it is shown similar results are obtained.

Anaerobic Conditions (Part I)

- 5 Electrodes installed at 12.5 cm in sands (would be at 25 cm or 10 cm for other soil conditions).



1: Interpreting for Anaerobic Conditions: Part II

- A soil meets the Anaerobic Conditions part of the standard if a positive reaction to alpha-alpha-Dipyridyl is the dominant (60% or more) condition of a specific layer (1/2 of 10 cm, 1/2 of 12.5 cm, or at least 10 cm of 30 cm) for at least 2 of the 3 required samples.

1: Anaerobic Conditions (Part II)

- A positive reaction to alpha-alpha-Dipyridyl is indicated by a pink/red color.

1: Interpreting for Anaerobic Conditions Part III:

For a soil to meet the Anaerobic Conditions part of the standard at least 3 of 5 IRIS tubes have iron removed from 30% of a zone 15 cm long. Top of zone of iron removal must be within 15 cm of the soil surface for all soils.

Anaerobic Conditions (Part III): These IRIS tubes were removed from a upland to wetland transect 21 days after installation. The two tubes on the right meet the Anaerobic Conditions part of the HSTS based on iron removal. The two on the left fail to meet the Anaerobic Conditions part of the HSTS based on iron removal.

IRIS tubes are available commercially or via construction.

Growing Season

- The classical concepts of “Growing Season” is not considered (28 degrees, leaf buds, etc.)
- NTCHS considers that Anaerobic Conditions (as confirmed by Eh and pH data) occur only when soil microbes are active (for wet soils this is throughout the year for most of the U.S.).

2: Saturated Conditions

- A. Confirmed by piezometer data.
- B. NTCHS recommends that the piezometer data be verified by open well data.
- C. On-site precipitation data are needed.

2: Saturation Measurements

- For Vertisols in Louisiana and Texas, 3 piezometers at 25 cm and 3 piezometers at 100 cm are installed. All are measured at least weekly.
- For all other soils, one open well to 2 m (preferable auto-recording), 2 piezometers at 25 cm, and 2 piezometers at 100 cm are installed. All are measured at least weekly.

2: Interpreting for saturated Conditions

- For a soil to meet the Saturated Conditions part of the standard, free water has to exist within the shallowest piezometer (25 cm).

2: Saturated Conditions

- Saturation or nor?
- 2 Piezometers at 25 cm
- 2 Piezometers at 100 cm
- Open well to a depth of 2 meters

Measurement Period

- Recommended measurement period is at least one year.
- Minimum measurement period captures a dry (moist)-wet-dry (moist) cycle.

Duration

- For at least 14 consecutive days, Anaerobic Conditions (confirmed by voltage readings below the Eh/pH line or positive reaction to alpha-alpha-Dipyridyl and Saturation Conditions must exist for a soil to be considered hydric.
- For Vertisols in Louisiana and Texas the minimum time period is 7 consecutive days for a total of 18 annual days.

Frequency

Frequency must be more than 50% (more than 1 in 2 years).
Three methods are approved to evaluate precipitation (Sprecher and Warne. 2000):

1. Direct Antecedent Rainfall Method
2. Moving Total Antecedent Rainfall Method.
3. Combining 1 and 2 above (Adjusted Moving Total Antecedent Rainfall Method).

Frequency Evaluation

1. Direct Antecedent Rainfall Method; precipitation data for the three months prior to the most saturated and reduced period are evaluated.
2. Moving Total Antecedent Rainfall Method; precipitation data during the most saturated and reduced period are evaluated.
3. Adjusted Moving Total Antecedent Rainfall Method; precipitation data for the three months prior to and during the most saturated and reduced period are evaluated.

1. Direct Antecedent Rainfall Method

Prior Month		WETS Rainfall Percentile		Measured Rainfall	Condition: Dry, Wet, Normal	Condition Value	Month weight	Multiply Previous two columns
	Name	30th	70th			(1=dry, 2=normal, or 3=wet)		
		----------inches----------						
1st (most recent)	July	4.09	7.15	4.53	Normal	2	3	6
2nd	June	2.84	5.34	5.10	Normal	2	2	4
3rd	May	3.01	5.64	9.58	Wet	3	1	3
							Sum	13
Rainfall of prior period was: drier than normal (sum is 6-9), normal (sum is 10-14), wetter than normal (sum is 15-18)								

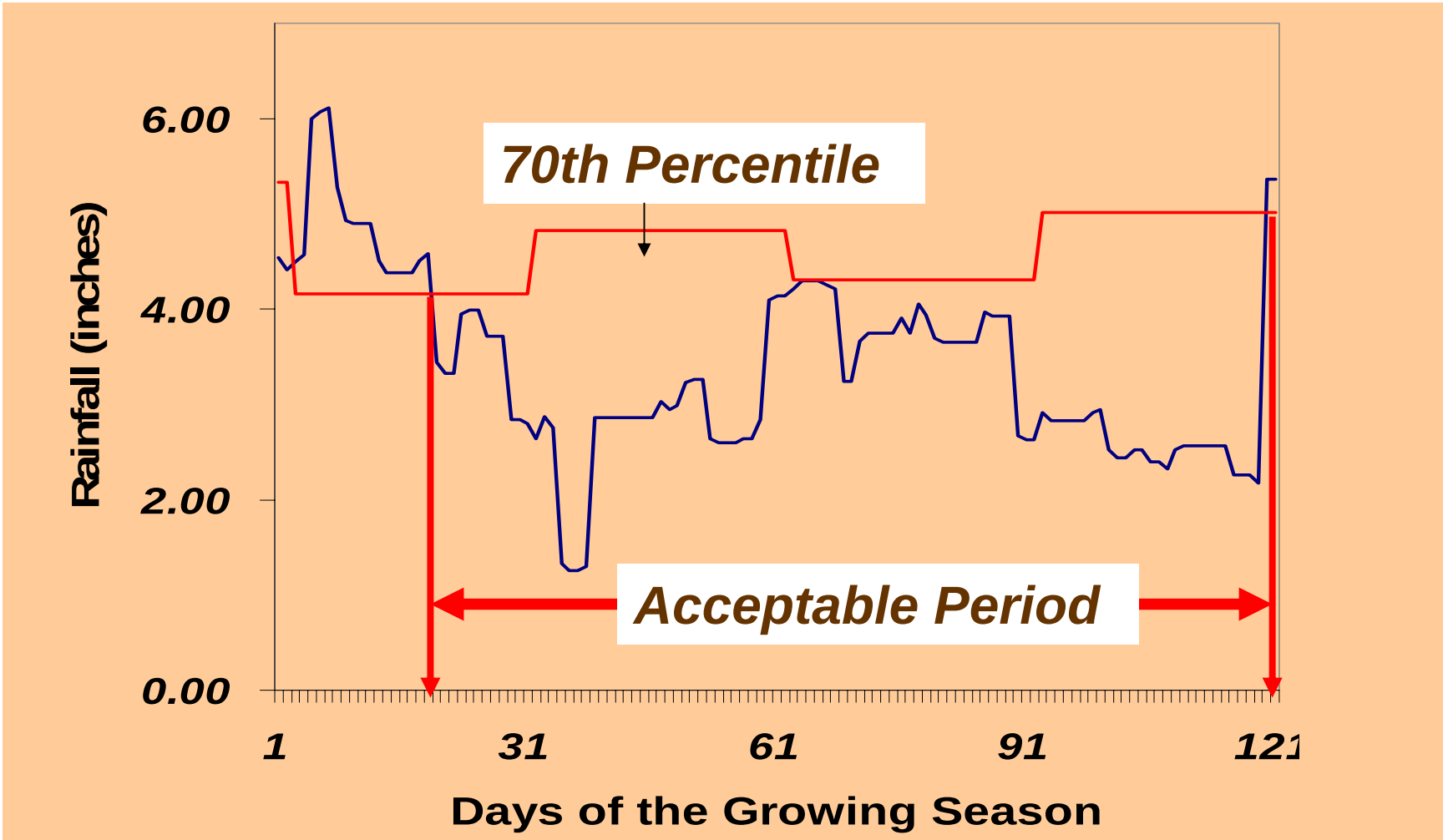
Most recent month is weighted more heavily than the 3rd month

2. Moving Total Antecedent Rainfall

Day	Rainfall (in)	Moving Total
28	0.87	
29	0.00	
30	0.04	4.54
31	0.16	4.42
32	0.12	4.50
33	0.12	4.57
34	1.42	6.00
35	0.08	6.07

Moving totals are a sum of 30 days. After the first 30 days, you subtract the first number out of the count and add the next number to the count.

2. Moving Total Antecedent Rainfall



3. **Combining 1 and 2 above (Adjusted Moving Total Antecedent Rainfall Method)**

This method combines both 1 and 2.

NTCHS approves all three methods but recommends the first method (Direct Antecedent Rainfall Method) be utilized.

Instrument Installation

- For application of the HSTS, instruments are installed at appropriate depths measured from:
- 1. The O Horizon surface in all soils that meet indicator A1 in all LRRs, or
- 2. The O Horizon surface in all soils that meet indicators A2, and A3 except in LRRs W, X, and Y, or
- 3. The Oa (muck) Horizon surface in soils that have a muck layer of any thickness at the surface except in LRRs R, W, X, and Y, or
- 4. The Oe (mucky peat) or Oi (peat) Horizon surface in soils in which they are directly underlain by sandy soil material in LRRs F, G, H, and M, or
- 5. The surface of the mineral soil in loamy and clayey soil materials that are overlain by Oe (mucky peat) or Oi (peat) Horizons in LRRs F, G, H, and M, or
- 6. The surface of the mineral soil in all LRRs except as noted above.

Commercially:

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5224 West 350 North
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The source indicated herein is in no way endorsed by the Government as being the preferred vendor of choice. Proposed acquisitions by the Government shall be in accordance with the applicable Federal Acquisition Regulations and in full compliance with the Competition and Contracting Act and Procurement Integrity Act.

Construction:

Quick (7 day) IRIS Tube Paint Recipe and Construction Procedure

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November 29, 2005; Revised July 6, 2006

1. Dissolve 16g of anhydrous FeCl3 in 0.5 L of distilled water (approximately 0.2M) in a 2 L beaker. Add a magnetic stir bar and place on a magnetic stirrer. The initial pH of this solution will be approximately 1.6. While stirring, monitor the pH as you add approximately 370 ml of 1M KOH until you reach a pH of 12 (use pH buffers of 7 and 10 (or higher) to standardize the pH meter rather than 4 and 7). At around pH 4, the Fe oxides will begin to precipitate rapidly and the suspension will become very thick. You will need to speed up the stir bar and continue to adjust it in order to maintain a stirred suspension.

Continue adding the KOH until the pH reaches 12.0, adding it more slowly and carefully as you approach the final pH. Allow the suspension to stand for approximately 30 minutes, then restart the stirring and check the pH. If it has dropped below 12.0, add additional KOH drop-wise to bring it back to the target pH. The total volume of suspension should be approximately 900 ml.

2. Transfer the suspension equally into four 250 ml nalgene bottles and centrifuge at approximately 1000 rpm for 5 min to concentrate the Fe oxides. Discard the supernatant. Transfer the contents of the four tubes into two 250 ml tubes and centrifuge wash the precipitated Fe oxide 2 times with distilled water, discarding the supernatant each time.

3. After the 3rd centrifugation, re-suspend the Fe oxides with distilled water and transfer to dialysis tubing. Place the dialysis tubing into basins filled with distilled water and replace the water at approximately 6 hr intervals during the first day and then at approximately 12 hr intervals for a total of 3 days. Transfer the Fe oxides from the dialysis tubing to a nalgene storage bottle and keep in the dark. The suspension should be suitable for painting IRIS tubes approximately 1 week (7 days) after the initial synthesis of the Fe oxides (this will vary based upon a number of factors including laboratory and storage temperature).

4. To get the paint to the right consistency, place the paint in a 250 ml centrifuge bottle and centrifuge at approximately 1000 to 1500 rpm for approximately 5 minutes. After centrifugation, decant the supernatant so that there is approximately the same volume of supernatant as the volume of the Fe oxide “cake” at the bottom of the bottle (see figure).

Then thoroughly re-suspend the Fe oxide and the paint should be at approximately the correct consistency for painting tubes.
5. Paint is applied to the tubes (½ inch schedule 40 PVC that has been cleaned with acetone to remove ink and lightly sanded with very fine sandpaper) using a 2" foam brush while the tube is spun using a cordless drill (typically we use 60 cm tubes and paint the lower 50 cm). Before painting a large number of tubes, be sure to test the paint by painting one or two prepared PVC IRIS tubes and allowing the paint to dry overnight. If the paint on the tubes is resistant to abrasion (does not rub off easily on your fingers) then proceed to paint and prepare IRIS tubes.
6. Once the paint has been tested, it should be stored in the refrigerator to minimize mineralogical alteration over time (Rabenhorst and Burch, 2006). Approximate shelf life when stored cold (refrigerated) is a couple of months. Tubes that have been painted have a long shelf life (a year or perhaps even up to several years) as long as they are kept dry.

References

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Rabenhorst, M. C., and K. L. Castenson. 2005. Temperature Effects on Iron Reduction in a Hydric Soil. Soil Sci. 170:734-742.
Castenson, K. L., and M. C. Rabenhorst. 2006. Indicator of Reduction in Soil (IRIS): Evaluation of a New Approach for
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Jenkinson, B.J., and D.P. Franzmeier. 2006. Development and evaluation of Fe-coated tubes that indicate reduction in soils.
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Jenkinson, B. 2002. Indicators of Reduction in Soils (IRIS): A visual method for the identification of hydric soils. Ph.D. diss.
Purdue Univ., West Lafayette.